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SEISMIC STRUCTURE LOADING RESPONSE SPECTRA COMPUTATION APPROACHES

PŘÍSPĚVEK K VÝPOČTU SPEKTER ODEZVY OBJEKTŮ ZATÍŽENÝCH SEISMICITOU

Abstract

One-dimensional (Shake) and three-dimensional (Flush) seismic response spectra modeling and computation were accomplished. This response spectra comparison present different spectral and frequency accelerations composition and peak ground acceleration. The response spectra differences are influenced by geotechnical, damping and structure transfer properties and also by the modeling approach. However the modeling approach and local soil properties influences are evident on the earthquake response spectra of structures because the input motion spectral composition was used identical for analyzing results set during the modeling.

Introduction

The estimation of earthquake motions at the structure site is the most important phase of the structure design in the dynamic analysis of the structure and its interaction with the geological beds under the structure. The rock motions could be amplified at the structure base by numerous factors. Therefore, there is a strong engineering motivation for a site-dependent dynamic response analysis to determine the free-field earthquake motions for many foundations (Wilson, E.L., 2002).

Subsoil geotechnical profiles properties on one side and soil structure interaction on the other side influence media transfer properties. Seismic response modeling approaches affects seismic response spectrum mode and spectral acceleration values in subsoil shallow geological structures vicinity. Present modeling approaches choice analysis impact on the site response spectrum variation of different geotechnical parameters of sedimentary, most horizontally, layered structures.

The one-dimensional (Shake) and the three-dimensional (Flush) approaches for pure shear models were applied to calculate the site response spectra at the base and optional structure points as well as at a free-field surface. Computed one-dimensional response spectrum and three-dimensional soil structure interaction (SSI) response spectrum are compared. Compared response spectra set correspond to the same earthquake input motion given at the base of a soil deposit and so his influence is irrelevant. The input motions given at the structure base were calculated before the soil structure interactive analysis, in the three-dimensional approach (Flush).

Site response spectrum computation approach differences

Many other recent earthquakes clearly illustrate the local soil properties importance on the structures earthquake response. The seismic response spectra computation results using the different one-dimensional and three-dimensional modeling approaches are compared. Three-dimensional seismic response spectrum computation, make use of the finite elements method. Soil structure interaction during seismic wave medium transition is taken into consideration, in this method. Soil and rock nonlinear properties changes and their different damping were applied. Viscid interfaces simulated three-dimensional effects were considered in the computation. The finite elements system defined like that allow seismic response spectrum computation at arbitrary structure and free-field surface points.

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Results analysis

The results constitute seismic response spectra, computed by one-dimensional and three-dimensional seismic response structures modeling approaches in maximal depth reached 60 m. This depth corresponds to geological structural and environmental units in which their transfer properties impact effect on passing seismic motion is strong. Results are presented on the following figures 1, 2 and 3, 4.

Figure 1 present one-dimensional (1) and three-dimensional (3) computed seismic response spectra which correspond to equivalent soil profiles geotechnical properties.

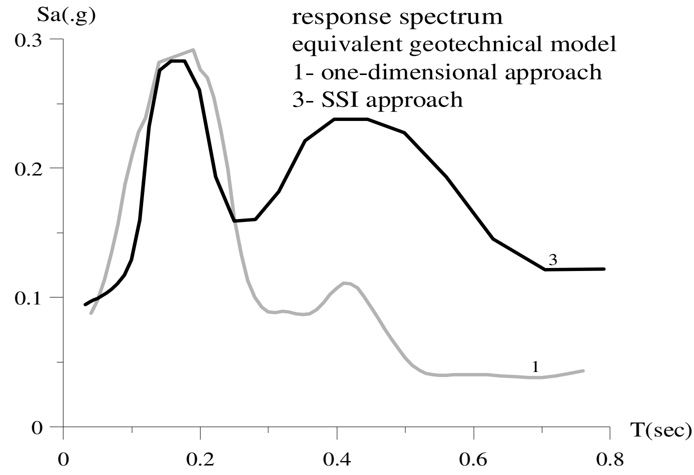

figure 1

Three-dimensional for free surface (3) and three-dimensional for soil-structure interaction (SSI) computed seismic response spectra comparison on the figure 2 correspond to variant soil profile geotechnical properties. Both (3) and (SSI) three-dimensional seismic response spectra are characterized by clear frequency composition changes and different spectral acceleration values (Sa) displacement for different frequency values. In spite of different soil geotechnical profiles composition, the values of Sa are influenced essentially. These spectral parameters deflections clearly correspond too different local soil geotechnical and structural geological properties changes.

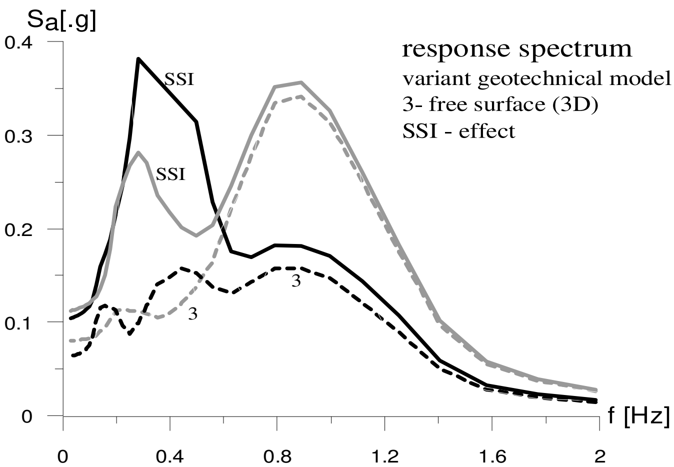

figure 2

One-dimensional (1) and both free surface (3) and soil-structure interaction (SSI) three-dimensional seismic response spectra are presented on figure 3. These spectra compare with these ones on figure 2, correspond to equivalent geotechnical profile but at the structure base applied seismic input motions are different in these figures. For spectra comparison on figures 3 and 4, these ones correspond to variant geotechnical profiles but the same seismic input motion applied at the structure base.

The different soil structure interaction effect is evident to compare one-dimensional and both (3) and SSI three-dimensional spectra lines on the figures. The difference between (3) and SSI three-dimensional lines is demonstrative in peak spectral acceleration values.

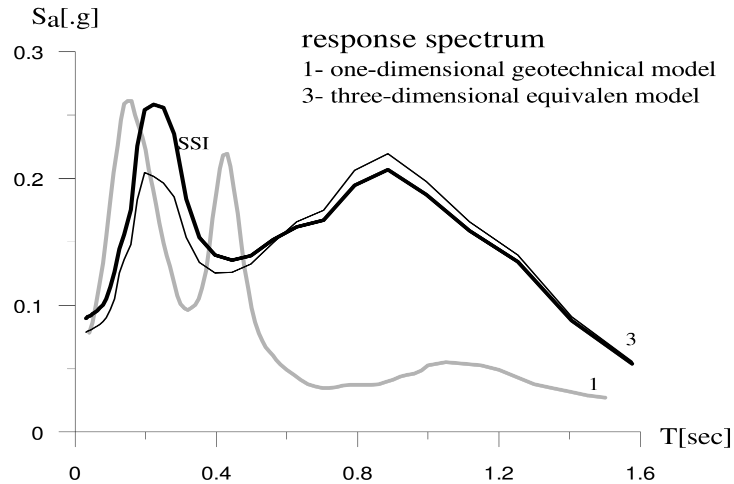

figure 3

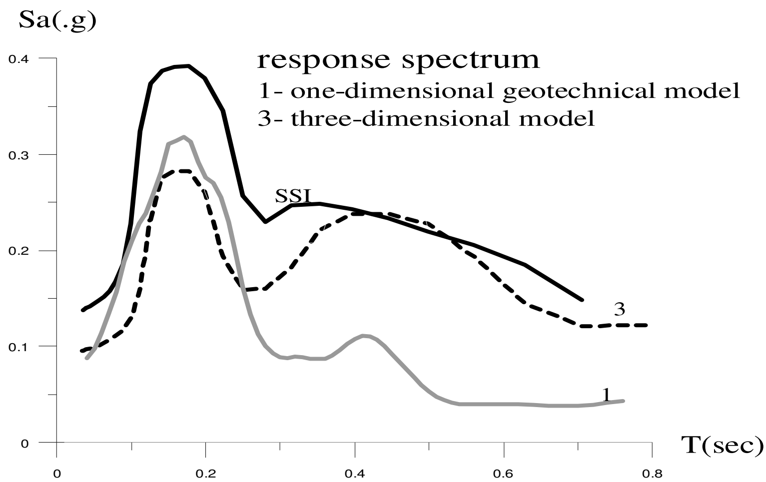

figure 4

Conclusion

One-dimensional and three-dimensional seismic response spectra modeling methods for variant geotechnical soil profiles and variant seismic input motion at the structure bases present very interesting features in comparison with their engineering practice applications. Three-dimensional finite elements method computed seismic response spectra reflect as geological structures transition properties as soil structure interaction influences. These influences in comparison with one-dimensional spectra are specific by the different shapes, frequency composition and higher spectral acceleration level Sa, while zero period acceleration (ZPA) remains similar. The most important differences are observed in peak spectral acceleration values. Since acceleration values constitute the seismic structure loading input parameters they have significant stability influence.

The finite elements methods ensure higher computation accuracy, but this method requires more input parameters for a greater accuracy rating.

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